CLAIMS

What is claimed is:

1. A method of selecting a data rate of a multicarrier communication channel, the method comprising:

calculating signal to noise ratios (SNRs) for subcarriers of the multicarrier communication channel from channel state information and a transmit power level;

estimating a throughput for each of a plurality of data rates from the SNRs; and

selecting one of the data rates based on the estimated throughputs.

2. The method of claim 1 wherein selecting one of the data rates comprises selecting a combination of one of a plurality of modulations and one a plurality of code rates associated with a highest of the estimated throughputs.

3. The method of claim 2 further comprising predicting packet error ratios (PERs) from the SNRs for each of the data rates, and

wherein the estimating the throughput comprises estimating a throughput for each of the data rates from the predicted PERs.

4. The method of claim 3 wherein predicting the PERs comprises using SNR performance curves for the plurality of data rates to determine a PER for each data rate, the SNR performance curves being predetermined and stored in a memory of a receiving station.

5. The method of claim 3 wherein the predicting PERs comprises:

after demapping bits of a current packet, calculating a bit-error rate (BER), based on a modulation of the current packet; and

after decoding the bits of the current packet, determining a PER for each of the plurality of data rates based on a predetermined BER performance of a decoder, the calculated BER, and a length of the current packet.

6. The method of claim 3 wherein the estimating the throughput comprises estimating a throughput for each data rate of the plurality by multiplying an associated one of the data rates by one minus the PER predicted for the associated data rate.

7. The method of claim 2 further comprising generating transmit power level and data rate instructions for a transmitting station, the transmit power level and data rate instructions to include the selected modulation and code rate and a selected transmit power level.

8. The method of claim 7 wherein the calculating operation is performed by a receiving station based on a known transmit power level provided by the transmitting station in a current packet, the current packet being a request to send (RTS) packet,

wherein the method further comprises:

determining, by the receiving station, the channel state information from channel estimates and noise power estimates performed on the RTS packet; and

sending, by the receiving station, the data rate instruction to the transmitting station in a clear-to-sent (CTS) packet, the transmitting station to responsively transmit at least portions of a data packet to the receiving station in accordance with the data rate instruction.

9. The method of claim 1 wherein the multicarrier communication channel comprises either a standard-throughput channel or a high-throughput communication channel, the standard-throughput channel comprising one subchannel, the high-throughput channel comprising a combination of one or more subchannels and one or more spatial channels associated with each subchannel, and

wherein calculating the SNRs comprises calculating SNRs for each subcarrier of the one or more subchannels and the one or more spatial channels comprising the multicarrier communication channel from the transmit power level and the channel state information, and

wherein the method further comprises generating a data rate instruction for a transmitter, the data rate instruction to include a selected modulation and a selected code rate for the one or more subchannels and the one or more spatial channels comprising the multicarrier communication channel.

10. The method of claim 9 further comprising determining the channel state information, the channel state information including noise power estimates and a channel transfer function for each subcarrier of the one or more spatial channels and the one or more subchannels.

11. The method of claim 9 wherein the high-throughput communication channel comprises one of:

a wideband channel having up to four frequency separated subchannels;

a multiple-input-multiple-output (MIMO) channel comprising a single subchannel having up to four spatial subchannels; and

a wideband-MIMO channel comprising two or more frequency separated subchannels, each subchannel having two or more spatial channels.

12. The method of claim 11 wherein the wideband channel has a wideband channel bandwidth of up to 80 MHz and comprises up to four of the subchannels,

wherein the subchannels are non-overlapping orthogonal frequency division multiplexed channels,

wherein each subchannel has a subchannel bandwidth of approximately 20 MHz and comprises a plurality of orthogonal subcarriers, and

wherein the one or more spatial channels are non-orthogonal channels associated with one of the subchannels.

13. The method of claim 9 wherein when the multicarrier communication channel is a high-throughput communication channel, the one or more spatial channels and the one or more subchannels are provided by a corresponding one or more transmit antennas of a transmitting station.

14. The method of claim 9 wherein the subcarriers of an associated subchannel have a null at substantially a center frequency of the other subcarriers to achieve substantial orthogonality between the subcarriers of the associated subchannel.

15. The method of claim 2 wherein the plurality of modulations comprise binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), 8PSK, 16-quadrature amplitude modulation (16-QAM), 32-QAM, 64-QAM, 128-QAM, and 256-QAM, and

wherein the plurality of code rates comprise forward error correction (FEC) code rates of ½, 2/3, and ¾.

16. The method of claim 1 wherein the data rate is further selected based on a mean-variance adaptation that includes a mean channel power gain based on channel gains for each of the subcarriers, a variance of the mean channel power gain, and predicted SNRs for each of the data rates.

17. The method of claim 1 wherein estimating the throughput comprises selecting various data rates for each of the subcarriers of the multicarrier communication channel based on the SNR for the associated subcarrier, and

wherein estimating the throughput comprises calculating throughputs for the multicarrier communication channel for the various data rates,

wherein selecting comprises selecting a single data rate for the subcarriers of one or more spatial channels and one or more subchannels of the multicarrier communication channel.

18. The method of claim 1 further comprising:

after calculating the SNRs for each subcarrier of the multicarrier communication channel, calculating a subcarrier capacity for each of the data rates based on the SNR calculated for an associated one of the subcarriers; and

refraining from estimating the throughput for each of the data rates, and

wherein selecting the data rate comprises selecting one of the data rates of the plurality based on a sum of the subcarrier capacities.

19. The method of claim 18 wherein the subcarrier capacity for each subcarrier is substantially calculated by multiplying a subcarrier frequency spacing by a logarithm of one plus the SNR for the associated subcarrier divided by a predetermined subcarrier SNR gap.

20. The method of claim 18 wherein selecting the data rate comprises:

determining an upper and a lower data rate based on the sum of the subcarrier capabilities;

calculating a first number of subcarriers with capacities higher than the upper data rate;

calculating a second number of subcarriers with capacities lower than the lower data rate; and

selecting the upper data rate when a difference between the first and second numbers is greater than a predetermined percentage of the subcarriers comprising the multicarrier communication channel.

21. A communication station comprising:

channel state information processing circuitry to calculate signal to noise ratios (SNRs) for subcarriers of the multicarrier communication channel from a transmit power level and channel state information; and

data rate selection circuitry to estimate a throughput for each of a plurality of data rates from the SNRs,

wherein the data rate selection circuitry selects one of the data rates based on the estimated throughputs.

22. The communication station of claim 21 wherein the data rate selection circuitry selects one of the data rates from a combination of one of a plurality of modulations and one a plurality of code rates associated with a highest of the estimated throughputs.

23. The communication station of claim 22 wherein the data rate selection circuitry further predicts packet error ratios (PERs) from the SNRs for each of the data rates and estimates the throughput comprises estimating a throughput for each of the data rates from the predicted PERs.

24. The communication station of claim 23 wherein the data rate selection circuitry predicts PERs comprises using SNR performance curves for the plurality of data rates to determine a PER for each data rate, the SNR performance curves being predetermined and stored in a memory of a receiving station.

25. The communication station of claim 23 wherein the data rate selection circuitry calculates a bit-error rate (BER), based on a known modulation of the current packet, and determines a PER for each of the plurality of data rates based on a predetermined BER performance of a decoder, the calculated BER, and a length of the current packet.

26. The communication station of claim 23 wherein the data rate selection circuitry estimates a throughput for each data rate of the plurality by multiplying

an associated one of the data rates by one minus the PER predicted for the associated data rate.

27. The communication station of claim 22 wherein the data rate selection circuitry generates transmit power level and data rate instructions for a transmitting station, the transmit power level and data rate instructions to include the selected modulation and code rate and a selected transmit power level.

28. The communication station of claim 27 wherein the channel state information processing circuitry and the data rate selection circuitry are part of a receiving station, and wherein the data rate selection circuitry calculates the SNRs based on a known transmit power level provided by the transmitting station in a current packet, the current packet being a request to send (RTS) packet,

wherein the channel state information processing circuitry determines the channel state information from channel estimates and noise power estimates performed on the RTS packet, and

wherein transmitter circuitry of the receiving station sends the data rate instruction to the transmitting station in a clear-to-sent (CTS) packet, the transmitting station to responsively transmit at least portions of a data packet to the receiving station in accordance with the data rate instruction.

29. The communication station of claim 21 wherein the multicarrier communication channel comprises either a standard-throughput channel or a high-throughput communication channel, the standard-throughput channel comprising one subchannel, the high-throughput channel comprising a combination of one or more subchannels and one or more spatial channels associated with each subchannel, and

wherein calculating the SNRs comprises calculating SNRs for each subcarrier of the one or more subchannels and the one or more spatial channels comprising the multicarrier communication channel from the transmit power level and the channel state information, and

wherein the communication station further comprises generating a data rate instruction for a transmitter, the data rate instruction to include a selected

modulation and a selected code rate for the one or more subchannels and the one or more spatial channels comprising the multicarrier communication channel.

30. The communication station of claim 29 where the channel state information processing circuitry further determines the channel state information, the channel state information including noise power estimates and a channel transfer function for each subcarrier of the one or more spatial channels and the one or more subchannels.

31. The communication station of claim 29 wherein the high-throughput communication channel comprises one of a wideband channel having up to four frequency separated subchannels, a multiple-input-multiple-output (MIMO) channel comprising a single subchannel having up to four spatial subchannels, and a wideband-MIMO channel comprising two or more frequency separated subchannels, each subchannel having two or more spatial channels.

32. The communication station of claim 31 wherein the wideband channel has a bandwidth of up to 80 MHz and comprises up to four of the subchannels,

wherein the subchannels are orthogonal frequency division multiplexed channels,

wherein each subchannel has a subchannel bandwidth of approximately 20 MHz and comprises a plurality of orthogonal subcarriers, and

wherein the one or more spatial channels are non-orthogonal channels associated with one of the subchannels.

33. The communication station of claim 29 further comprising one or more antennas to communicate over the one or more spatial channels and the one or more subchannels when the multicarrier communication channel is a high-throughput communication channel.

34. The communication station of claim 29 wherein the subcarriers of an associated subchannel have a null at substantially a center frequency of the other

subcarriers to achieve substantial orthogonality between the subcarriers of the associated subchannel.

35. The communication station of claim 22 wherein the plurality of modulations comprise binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), 8PSK, 16-quadrature amplitude modulation (16-QAM), 32-QAM, 64-QAM, 128-QAM, and 256-QAM, and

wherein the plurality of code rates comprise forward error correction (FEC) code rates of ½, 2/3, and ¾.

36. The communication station of claim 21 wherein the data rate selection circuitry further selects the data rate based on a mean-variance adaptation that includes a mean channel power gain based on channel gains for each of the subcarriers, a variance of the mean channel power gain, and predicted SNRs for each of the data rates.

37. The communication station of claim 21 wherein the data rate selection circuitry selects various data rates for each of the subcarriers of the multicarrier communication channel based on the SNR for the associated subcarrier, and calculates throughputs for the multicarrier communication channel for the various data rates,

the data rate selection circuitry further selects a single data rate for the subcarriers of one or more spatial channels and one or more subchannels of the multicarrier communication channel.

38. The communication station of claim 21 wherein the data rate selection circuitry calculates a subcarrier capacity for each of the data rates based on the SNR calculated for an associated one of the subcarriers for each subcarrier of the multicarrier communication channel,

the data rate selection circuitry refrains from estimating the throughput for each of the data rates, and

the data rate selection circuitry selects one of the data rates of the plurality based on a sum of the subcarrier capacities.

39. The communication station of claim 38 wherein the data rate selection circuitry calculates the subcarrier capacity for each subcarrier substantially by multiplying a subcarrier frequency spacing by a logarithm of one plus the SNR for the associated subcarrier divided by a predetermined subcarrier SNR gap.

40. The communication station of claim 38 wherein the data rate selection circuitry:

determines an upper and a lower data rate based on the sum of the subcarrier capabilities;

calculates a first number of subcarriers with capacities higher than the upper data rate;

calculates a second number of subcarriers with capacities lower than the lower data rate; and

selects the upper data rate when a difference between the first and second numbers is greater than a predetermined percentage of the subcarriers comprising the multicarrier communication channel.

41. A system comprising:

a substantially omnidirectional antenna;

a receiver to receive signals through then antenna through a multicarrier communication channel;

channel state information processing circuitry to calculate signal to noise ratios (SNRs) for subcarriers of the multicarrier communication channel from a transmit power level and channel state information; and

data rate selection circuitry to estimate a throughput for each of a plurality of data rates from the SNRs and select one of the data rates based on the estimated throughputs.

42. The system of claim 41 wherein the data rate selection circuitry selects one of the data rates from a combination of one of a plurality of modulations and one a plurality of code rates associated with a highest of the estimated throughputs.

43. The system of claim 42 wherein the data rate selection circuitry further predicts packet error ratios (PERs) from the SNRs for each of the data rates and estimates the throughput comprises estimating a throughput for each of the data rates from the predicted PERs.

44. A machine-readable medium that provides instructions, which when executed by one or more processors, cause the processors to perform operations comprising:

calculating signal to noise ratios (SNRs) for subcarriers of an orthogonal frequency division multiplexed communication channel from a transmit power level and channel state information;

estimating a throughput for each of a plurality of data rates from the SNRs; and

selecting one of the data rates based on the estimated throughputs.

45. The machine-readable medium of claim 44 wherein the instructions, when further executed by one or more of the processors cause the processors to perform operations further comprising selecting one of the data rates based on selecting a combination of one of a plurality of modulations and one a plurality of code rates associated with a highest of the estimated throughputs.

46. The machine-readable medium of claim 45 wherein the instructions, when further executed by one or more of the processors cause the processors to perform operations further comprising predicting packet error ratios (PERs) from the SNRs for each of the data rates, and

wherein estimating the throughput comprises estimating a throughput for each of the data rates from the predicted PERs.